

A collage of 12 images related to space exploration and astronomy. The images include: a colorful nebula with green, blue, and purple hues; a close-up of the sun's fiery orange and red surface; the International Space Station in orbit over Earth; a lunar lander on the moon's surface; bright white lightning bolts against a dark blue sky; the interior of a space station module with a circular hatch; an astronaut in a white suit floating in space; a bright meteor streaking across a dark sky; a view of Earth from space with a green aurora; a close-up of a space station module; and a vast, glowing orange and yellow nebula.

Jimmy Lee / VP33

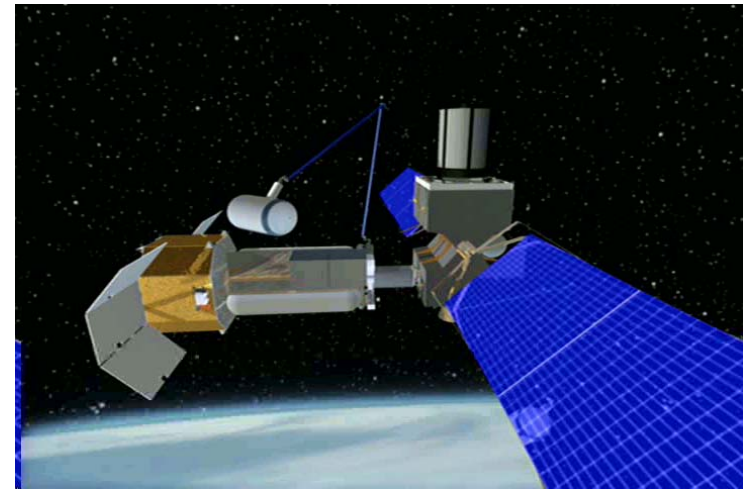


Orbital Express Background

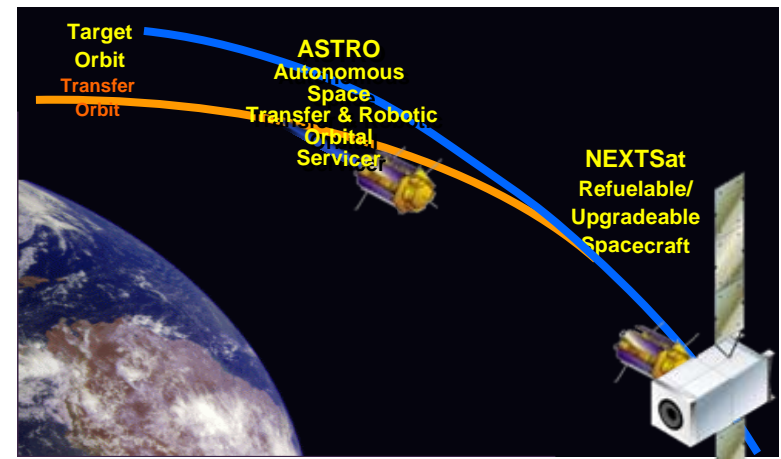


SCIENCE & MISSION SYSTEMS

- Orbital Express (OE) is a DARPA managed mission to demonstrate minimal capabilities for on-orbit servicing and resupply of some consumables.
 - NASA ESMD has invested approximately \$40M in Orbital Express
- DARPA Orbital Express Objectives
 - Demonstrate the technical feasibility and utility of Autonomous On-Orbit Satellite Servicing
 - Develop Non-Proprietary Satellite Interfaces
 - Three month to one year mission with multiple demonstrations
- MSFC Orbital Express Mission Objective
 - Demonstrate use of AVGS technology for Automated Rendezvous and Docking (AR&D)
- Launched on March 8, 2007



On-Orbit Servicing



Orbital Express

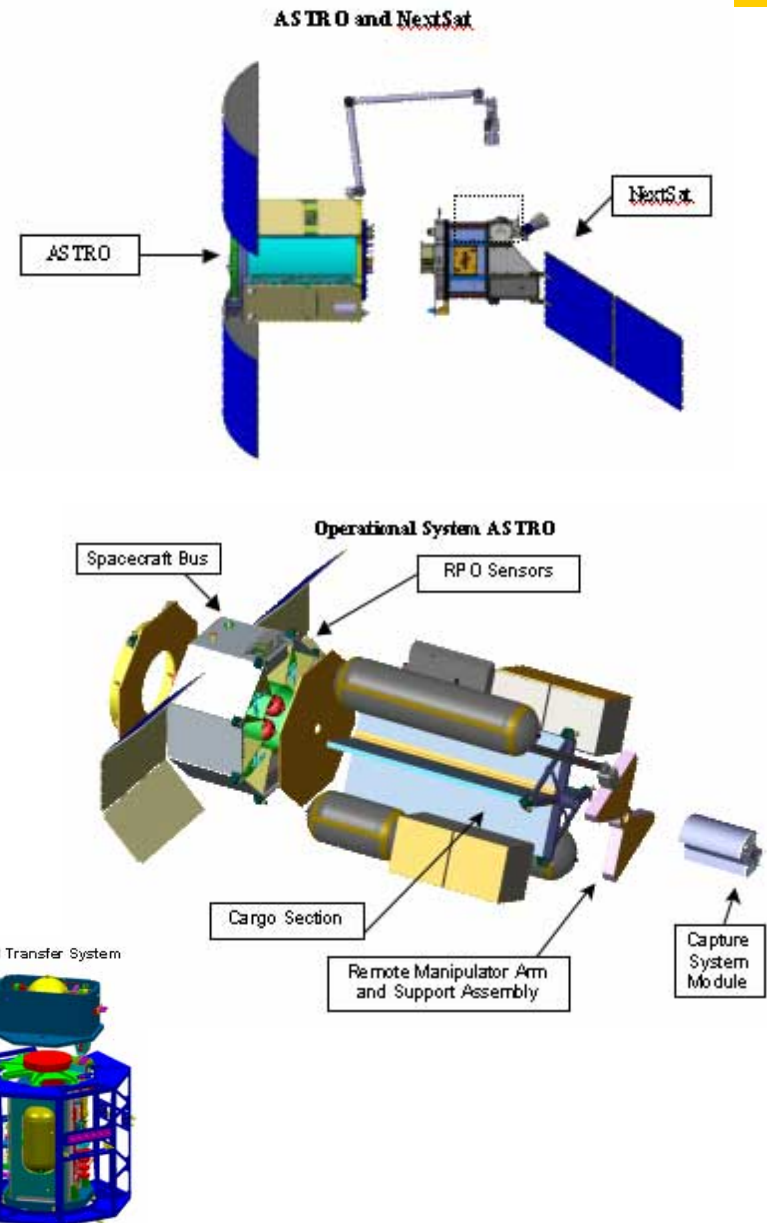


Orbital Express Benefits to NASA



SCIENCE & MISSION SYSTEMS

- Benefits to AR&D
 - First orbital demonstration of an integrated AR&D sensor suite, including the NASA AVGS and Boeing sensors, for proximity operations and docking
- Other benefits to future NASA needs
 - Demonstration of Robotic Fluid Coupler
 - Use of Robotic arm to replace ORUs
 - Limited refueling and/or Servicing of Future Vehicles and Facilities



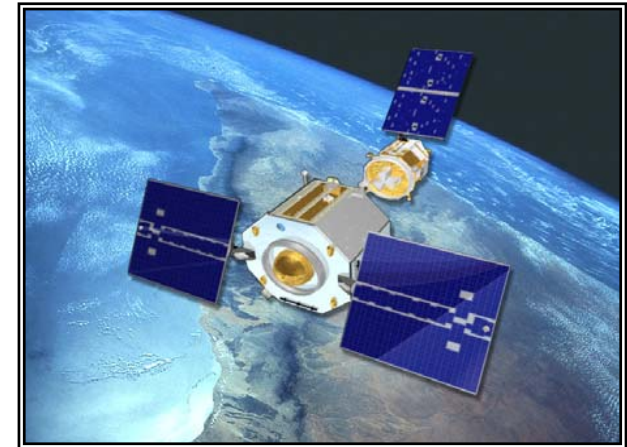


MSFC Orbital Express Tasks

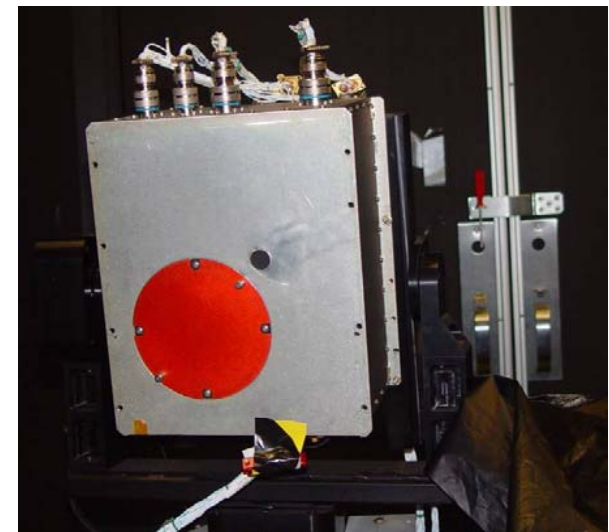


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- MSFC task agreements were defined such that deliverables and support were provided to Boeing as the primary customer
 - Boeing is the DAPRA OE Prime Integrator and responsible for development of ASTRO chase vehicle which contains the AVGS
- MSFC was responsible for deliverables and support for the Orbital Express Program as follows
 - AVGS Optical System
 - AVGS Flight Software
 - AVGS Optical Characterization and Performance Testing
 - AVGS Emulator Development and Support
 - OE Docking Mechanism Qualification Testing
 - Automated Rendezvous and Capture Sensor Suite (ARCSS) Open Loop System Level Testing
 - Orbital Express Mission Support



Orbital Express



AVGS Flight Unit



MSFC S&MS / ED Organizations



SCIENCE & MISSION SYSTEMS

VP01 / Science & Mission Systems Office

John Horack, Manager

VP10 / Program Planning
& Control Office

VP02 / NSSTC
Executive Staff

VP30 / Exploration & Space Ops
Programs & Projects Office

VP40 / Lunar
Programs & Projects Office

VP50 / Science
Programs & Projects Office

VP60/ Science & Exploration
Research Office

ED01 / Engineering Directorate

Mike U. Rudolphi, Director

ED04/ Chief Engineers
Office

ED02/ Resource
Management Office

ED03/ Engineering
Programs & Sys. Office

AR&D
Projects

EI01 / Instrument & Payload
Systems Department

EV01 / Spacecraft & Vehicle
Systems Department

ER01 / Propulsion Systems Dept.

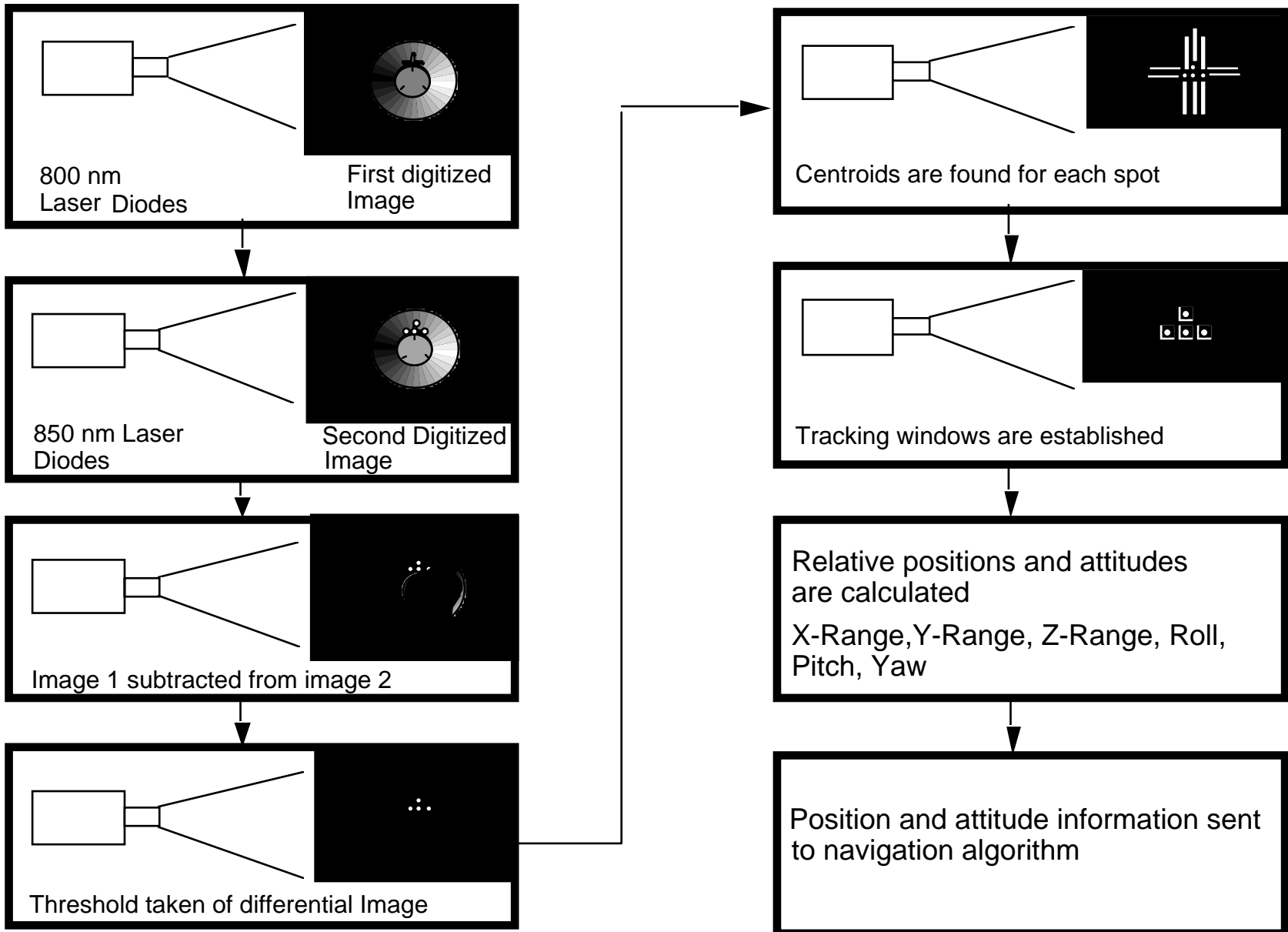
EO01/ Mission Operations Lab

EM01/ Materials & Processes
Laboratory

ET01/ Tests Laboratory



BASIS OF VIDEO GUIDANCE SENSOR OPERATION



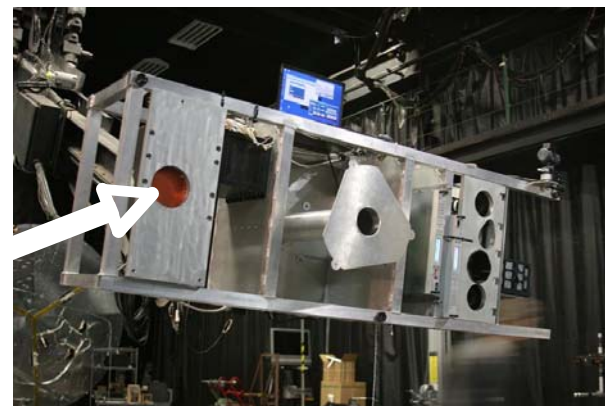


MSFC Orbital Express Task Status

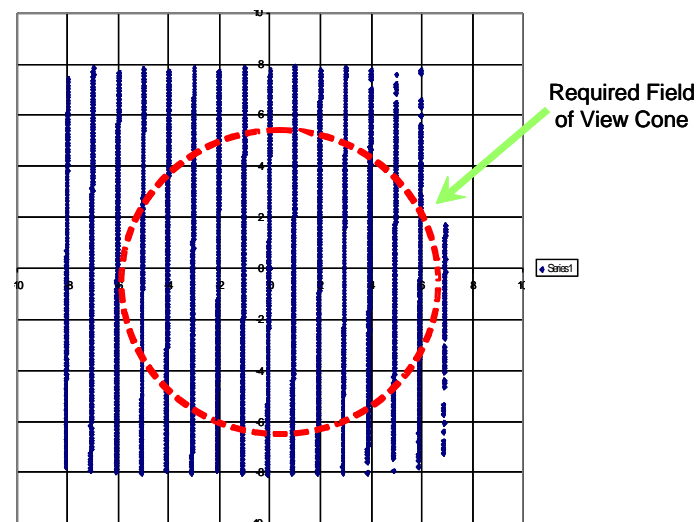


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- Completed all MSFC deliverables and pre-launch support tasks
- MSFC stepped up during the project to provide essential support to resolve engineering issues with AVGS Flight hardware as delivered by OSC to Boeing
- MSFC efforts resulted in successful delivery of AVGS to Boeing for Spacecraft Integration
- MSFC participated in Pre-Mission Dress Rehearsals and is supporting Mission Operations



OE ARCSS EDU Testing at FRL



AVGS FOV Coverage



Orbital Express AVGS Mission Objectives



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- Conduct multiple rendezvous and docking mission events to obtain adequate assessment of AVGS performance
 - Current plan is a single AVGS event as primary AR&D sensor plus six “blended mode” events using Boeing sensor plus AVGS
- Perform quick-look analysis of AVGS performance during mission and provide operations inputs to Boeing if needed
- Perform detailed post-mission analysis of AVGS performance and use for NGAVGS development



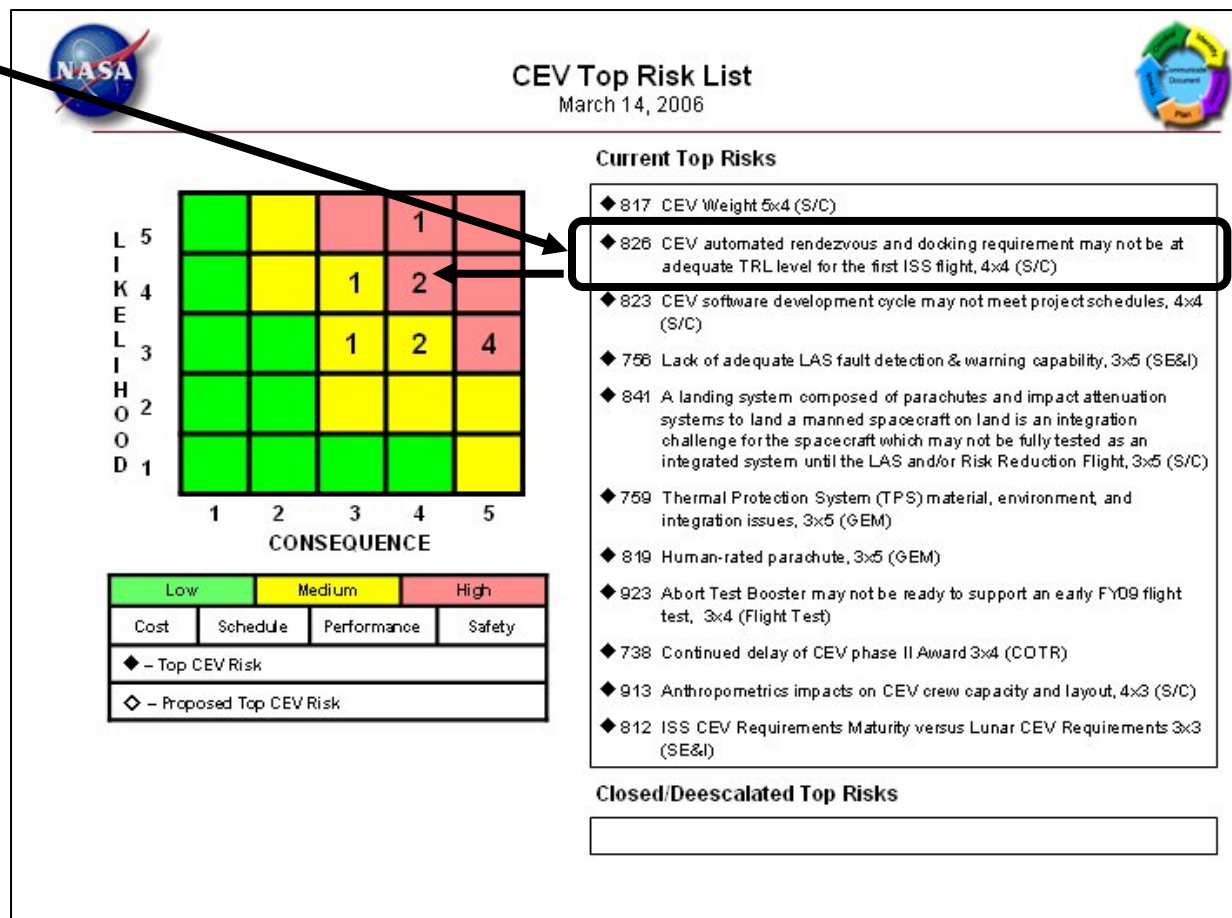


NASA AR&D Risks



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- AR&D is identified as one of the top CEV Risks
 - The risk is primarily in sensor readiness to meet first flight of CEV to ISS
- COTS requires AR&C for all uncrewed operations
- Future Constellation missions may require multiple launches and LEO assembly



NASA OE Team is supporting JSC CEV RPOD

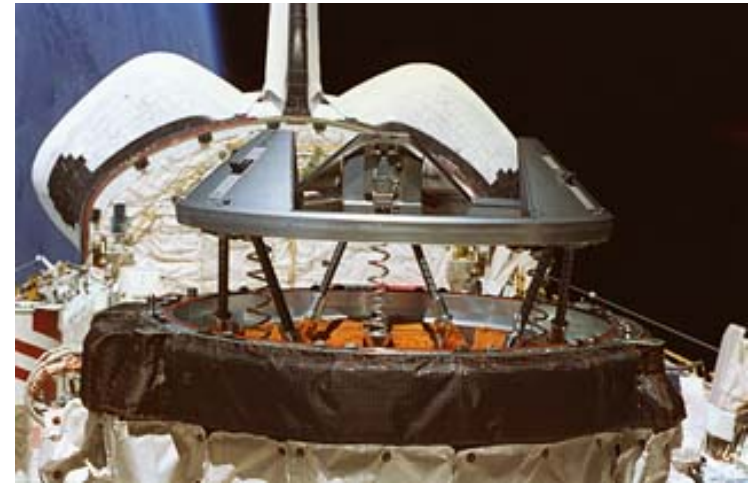


Where is AR&D Today?

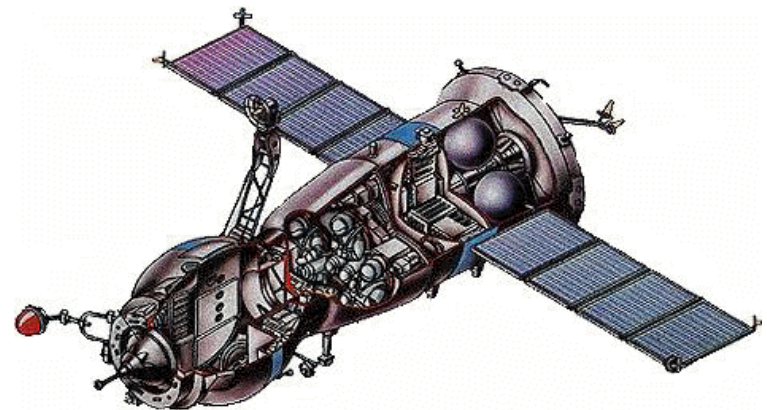


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- **The U.S. does not have an AR&D system capability and is reliant on manned control for rendezvous and docking of orbiting spacecraft**
- **Existing Russian AR&D sensor hardware is not appropriate to use or adapt**
- **Gaps Exist in Current US AR&D System Development**
 - No satisfactory far field sensor exists
 - No satisfactory androgynous, redundant docking mechanism exists
 - No proximity operations and docking sensor exists at the required TRL
 - Autonomous flight manager software is needed



Shuttle / ISS Docking Port



Soyuz with KURS



AR&D Development Needs

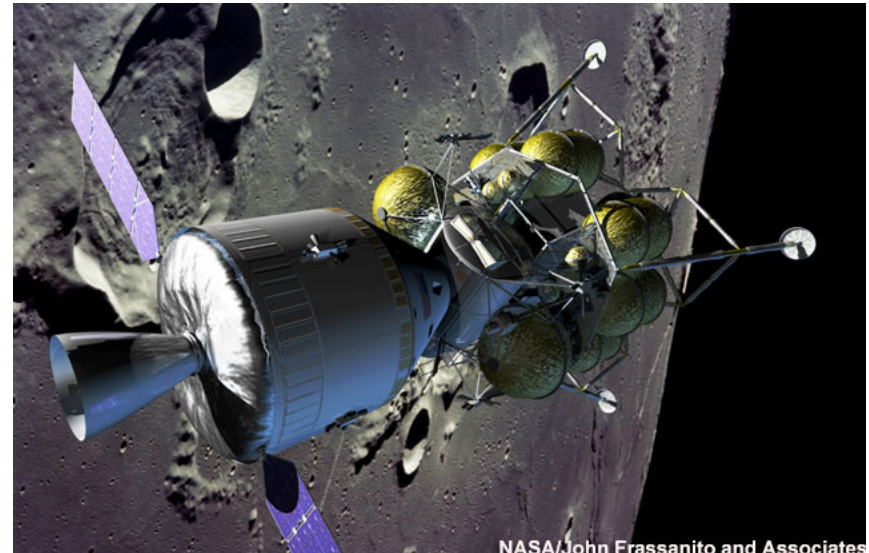


SCIENCE & MISSION SYSTEMS

- **AR&D is a key long lead enabling system**
 - CEV cargo missions to ISS*
 - Commercial cargo re-supply to ISS*
 - Lunar transfer assembly
 - Mars Sample Return
 - DOD on-orbit servicing
- **An integrated program is needed to develop and demonstrate AR&D**



NASA/John Frassanito and Associates



NASA/John Frassanito and Associates

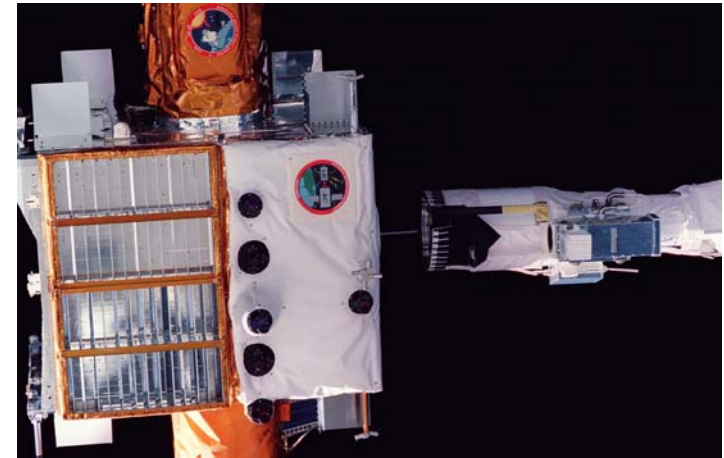


MSFC is Strategically Positioned to Support AR&D



SCIENCE & MISSION SYSTEMS

- **MSFC Rendezvous and Docking Sensor technology has a high level of maturity**
 - VGS flight tested on STS 87 and STS 95
 - AVGS flight tested on DART and OE flight test underway
 - NGA VGS to address parts obsolescence and radiation hardening
- **MSFC has the appropriate skill mix to support AR&D Development for CEV**
- **MSFC has unique, “world class”, AR&D test facilities**



STS 95 Spartan Deployment



Flight Robotics Lab



CEV AR&D Sensor Testing



Orbital Express Launch and Activation



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- STP-1 Launched on 3/8/2007 at 10:10 EDT
 - Orbital Express is primary payload
 - Three secondary satellites deployed from ESPA (EELV Secondary Payload Adapter) ring
 - MidSTAR 1 (US Naval Academy)
 - FalconSat 3 (US Air Force Academy)
 - STPSat 1 (Space Test Program)
- OE separated from the Atlas V at 10:28 pm EST into a 492-km circular orbit with a 46.0 degree inclination
- Following separation, the solar arrays were deployed and a heartbeat detected
- OE activation and checkout continues
- Operations replan took place after initial issues were worked
- Unmated operations scheduled to begin on 4/16
 - ARCSS sensor checkout, including AVGS
 - MSFC to support unmated operations at the Engineering Support Room, Boeing, Huntington Beach

